SYNTHETIC AND NATURAL NAKHLA PYROXENES: MINOR ELEMENTS COMPOSITION. K. Kaneda[1], G. McKay[2], and L. Le[3], [1]Mineralogical Institute, Graduate School of Science, University of Tokyo 113, Japan, [2]SN4, NASA-JSC, Houston, TX 77058, USA, [3]Lockheed Martin, 2400 NASA Road 1, Houston, TX 77058, USA.

Introduction: Nakhla, which is one of the SNC meteorites, is mainly composed of CPX, olivine and mesostasis. The pyroxenes have igneous elemental zoning, especially with respect to Mg, Al, Ti and Fe, which would preserved information about the formation process of Nakhla and the composition of the Martian magma from which it was formed. A series of crystallization experiments were performed over a range of cooling rates using a synthetic Nakhla composition. By comparing the compositions and textures of pyroxenes from these experiments with natural pyroxenes in Nakhla, we hope to provide additional constraints on the formation of Nakhla.

Experiment: Experimental starting material NJ3 was made by mixing of our earlier synthetic compositions, NJ2 and NL1. A series of experiments were then performed to determine its liquidus temperature. Pellets of NJ3 were placed on 8 mil Pt/Rh loops, fused ~1350°C for 48 hours in a gas mixing furnace at fO_2=QFM, then quenched to room temperature. Homogenized charges were put back in the furnace slightly below the liquidus temperature, then cooled linearly or non-linearly to 200° below their liquidus temperature, and quenched to room temperature. These quenched charges contained small amount of glasses, zoned pyroxenes and Cr-Ti spinel. Pyroxenes and melts were then analyzed with Cameca Camebax Electron Microprobe. The Cameca SX100 Electron Microprobe was used to acquire elemental maps of the pyroxenes to study zoning patterns.

Results: Average glass compositions show no significance difference among experiments of NJ3, except volatile elements such as Na, P and K. These elements were depleted during the experiments. The core compositions of NJ3 synthetic pyroxenes are shown in Fig. 1. They have fairly fixed composition in this quadrilateral diagram regardless of different cooling rate, and they resemble pyroxenes from earlier experiments with the NL composition [1][2]. The plots of synthetic pyroxenes have a trend shown as a broken line on the diagram. This trend shows the chemical zoning of NJ3 pyroxenes. The compositions of NJ3 pyroxene do not deviate significantly from this trend. The compositions of NJ3 pyroxenes are a little lower in Fe and a little higher in Ca than that of natural Nakhla pyroxenes, probably reflecting differences between our melt composition and the Martian magma. Al_2O_3-TiO_2 plot is shown in Fig. 2. Al and Ti contents in earlier experimental pyroxenes, except for NJ, do not overlap the range of the Nakhla pyroxenes. Only those of NJ pyroxenes fall in the low Al-Ti range of Nakhla pyroxenes. New NJ3 experimental pyroxenes overlap much of the range; however, the slope of the Al_2O_3/TiO_2 trend for NJ3 pyroxenes is different from that of Nakhla pyroxenes. Figure 3 shows Al_2O_3-TiO_2 plot of each NJ3 experiment. The trends for six experiments, NJ3-654A (isothermal), 656B (isothermal), 664 (cooling at 1°C/h), 662 (at 1.5°C/h), 657 (at 2°C/h) and 666 (at 2°C/h) intersect at one area, regardless of the difference in Al_2O_3/TiO_2 slope. And at cross point, they have lowest Fe/Mg ratio. Therefore, this area shows the composition of the real NJ3 pyroxene core. The trends of NJ3-658 and 659 do not cross at this area, because they were cooled too fast and might have small cores. The composition where the trends intersect is a little more Ti-rich than the Nakhla pyroxene cores.

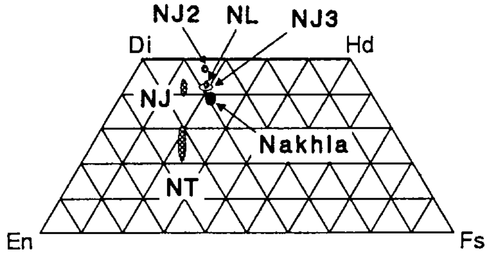

Fig. 1. Synthetic pyroxenes and Nakhla pyroxenes composition.

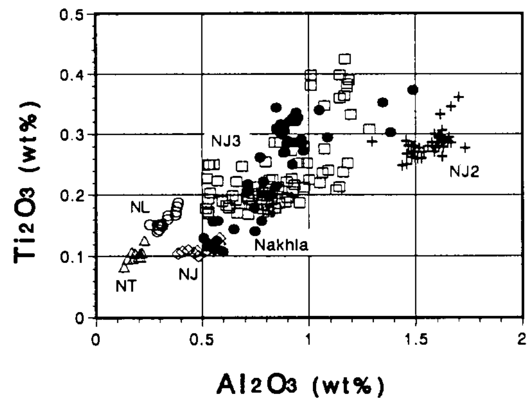

Fig. 2. Al_2O_3-TiO_2 contents of synthetic pyroxenes and Nakhla pyroxenes.

Conclusions: The major element (Mg and Fe) and minor element (Al and Ti) composition of pyroxene cores is almost constant regardless of cooling rate. This suggests that cooling rate can affect the trends of chemical zoning, but cannot affect the major element and minor element compositions of the initial pyroxene cores. The core composition of NJ3 pyroxene is little higher in Ca and Ti, and little lower in Fe than that of Nakhla pyroxenes. Therefore, the Martian magma from which Nakhla was formed might be less Ca-rich than NJ3.

References: [1] G. McKay *et al.* (1993) *LPS*, ***XXIV***, 965-966. [2] G. McKay *et al.* (1994) *LPS*, ***XXV***, 883-884.

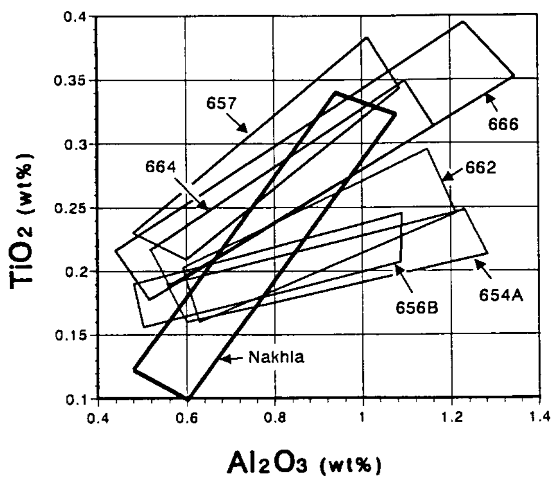

Fig. 3. Al_2O_3-TiO_2 plot of each NJ3 experiment and Nakhla pyroxenes.

NJ3 composition	
Na_2O	1.09
MgO	4.61
Al_2O_3	5.72
SiO_2	49.54
P_2O_5	0.35
K_2O	1.50
CaO	12.89
TiO_2	1.03
Cr_2O_3	0.09
MnO	0.57
FeO	22.63

Cooling rate	
654A	isothermal
655	isothermal
656B	isothermal
657	2°C/h
658	non-linear
659	4°C/h
660	non-linear
661	2°C/h
662	1.5°C/h
664	1°C/h
666	2°C/h